

RED ROCK DOMTAR EFFLUENT PLUME CHEMISTRY 1975 UPDATE



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Ministry
of the
Environment

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RED ROCK DOMTAR
EFFLUENT PLUME CHEMISTRY
1975 UPDATE

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INTRODUCTION

The most important results obtained from the 1974 survey in the vicinity of a large paper mill at Red Rock on Lake Superior was the determination of the dependence of the plume conductivity on the distance from the outfall. Two different statistical methods, one-dimensional and two-dimensional, were used to describe the plume spread. In both cases, statistical limits of the fitted lines were wide making it difficult to extrapolate the results. It was decided to try to improve these predictions in 1975 by placing recording conductivity meters at several fixed positions in the plume and to record the changes with concurrent monitoring of the outfall conductivity and winds in the area. The experimental part of the 1975 survey was partially successful and the results are given here.

MEASURING TECHNIQUE

Two Lisle Instrument conductivity meters equipped with chart recorders were mounted on the floating platforms and moored in the bay. A Leeds and Northrup conductivity (and pH) meter was installed to continuously monitor the water in the outfall ditch. A recording wind anemometer was also installed near the outfall to record the direction and speed of the winds in the area.

DATA ANALYSIS

1. Discharge conductivity

Results of the outfall conductivity between June 17 and June 29, 1975 (longest uninterrupted record) were digitized by reading mean hourly values from the chart. The mean value for the record was calculated to be 660.1 umhos/cm with a standard deviation of 98.5 umhos/cm for a total of 290 hourly readings. The record was subjected to the time series analysis after the series was filtered first to remove random noise and low frequency trend. The only significant periodicity (at 80 percent confidence level) was found to have a period of 24 hours. This could possibly be attributed to the periodic increase of the mill activity during certain hours of the day. No shorter significant periods were found which might have suggested similar periodicity of activity on each shift.

2. Winds

Wind data were collected in a way similar to that of last year. A summary of the individual frequencies by speed and directions are given in Table 1 and it is also compared with last year's data in Figure 1. As can be seen, the bi-directionality of the data is evident again and 1975 data resemble closely winds measured in 1974.

3. Plume Conductivity

It was shown in last year's report that, generally, the chemistry of the plume can be conveniently expressed by the plume's conductivity. The method of improving the data of the 1974 survey was to obtain continuous recording of the plume conductivity at two directions and distances from the outfall. These recordings, together with the record of the outfall conductivity and winds should improve the prediction of the spread of the plume.

Two conductivity meters were placed first in approximately north-south directions at 300 and 1000 meters from the outfall to record the spread of the plume along the shore. Later on, the same meters were moored in east-west direction at distances of 200 and 800 meters. Unfortunately, only one meter, in the north-south direction at the distance of 300 meters from the outfall, recorded meaningful data from June 18 to July 4, 1975. The positioning of this meter as well as the direction of the lines are shown in Figure 2. From recorded conductivity "c" at this distance, conductivity at the outfall "c₀" and background conductivity "c_b" (c_b=100 umhos/cm used throughout the study based on last's years data), the reduced conductivity defined as $c_r = (c - c_b) / (c_0 - c_b)$ was calculated. The means and standard deviations classified by the directions the main winds were blowing from are as follows:

<u>Winds</u>	<u>Mean C_r</u>	<u>Std. Dev.</u>	<u># of Hourly Readings</u>
N + NW	0.301	0.060	94
S + SE	0.324	0.061	224
ALL	0.319	0.066	362

The resulting c_r values, together with their 95 percent confidence limits, are shown in Figures 3 to 5. As can be seen, the mean values are generally slightly above the values calculated from last year's surveys, but are within 95 percent confidence limits of the line. The prediction for the NW winds appears to be better than for the SE wind state. Unfortunately, one data point is not enough to improve the predictive lines and to extend the range of the predictions.

CONCLUSIONS

This year's extension of the study of the plume near Red Rock in the Nipigon Bay area of Lake Superior shows that the data and conclusions based on last year's study are satisfactory and that the winds and the plume spread findings agree with the previous records. There appears to be a slight diurnal periodicity in the outfall conductivity suggesting periodic increase of the mill activity on a daily basis.

APPENDIX

Also added to this report are some chemistry records from 1974 which were not available for the 1974 Report. Table 2 is identical to Table 12 from last year's report and is included here as part of that table was missed during the final printing of the report. To show the positions of the individual samples, Figure 6 is enclosed (identical to Figure 22 of the 1974 report). Additional information on fatty acids is given in Table 3.

TABLE 1: Frequency Table, Winds at Red Rock June 4 - July 12, 1975

Speed m/sec	D I R E C T I O N C O M I N G F R O M								Row Sums
	N	NE	E	SE	S	SW	W	NW	
0.00 - 1.33	0.18	0.36	0.09	0.18	0.18	0.36	0.36	1.09	2.80
1.34 - 5.36	12.88	2.00	0.82	18.06	14.62	4.36	0.54	14.24	67.52
5.37 - 6.70	2.27	0.00	0.00	7.44	6.00	0.09	0.00	2.81	18.61
6.71 - 8.05	1.00	0.00	0.00	2.00	2.72	0.00	0.00	2.18	7.90
8.06 - 10.73	1.54	0.00	0.00	0.45	1.00	0.00	0.00	0.18	3.17
Column Sums	17.87	2.36	0.91	28.13	24.52	4.81	0.90	20.50	100.00

TABLE 2: Composition of Collected Samples, Red Rock 1974

Sample No.	Depth m	Date	Conduc-tivity umhos/cm	Chlorides as Chlorine	Solids Total	Diss. Susp.	Phenol ppb	COD	BOD	Alkal-inity	pH	Turbid-ity F.T.U.	Sodium as Na	Potas-sium as K	Sulphate as SO ₄	
1	0.2	Jul 4	227	11.5	250	240	10	125	75	-	89	7.8	6.5	25	1.9	23.0
2	0.2	Jul 4	235	11.5	260	250	10	113	75	-	91	8.0	6.0	27	1.9	24.5
3	0.2	Jul 4	265	14.5	115	95	20	213	105	-	94	7.8	14.0	34	2.2	29.5
4	0.2	Jul 8	440	-	440	420	20	240	190	85	123	7.4	27.0	68	3.5	-
5	0.2	Jul 8	340	-	220	215	5	120	115	50	93	7.5	17.0	61	3.2	-
6	1.0	Jul 8	140	3.1	70	67	3	20	L10	3.4	71	7.8	2.0	4.5	1.0	4.8
7	0.2	Jul 8	136	2.5	65	62	3	11	L10	2.4	68	7.7	1.7	3.8	1.0	6.0
8	0.2	Jul 8	148	3.7	85	80	5	17	L10	6.0	71	7.8	2.7	6.0	1.1	6.6
9	0.2	Jul 8	126	1.5	67	63	2	-	L10	1.6	65	7.9	1.5	2.3	0.9	3.2
10	1.0	Jul 8	138	4.8	75	71	4	29	L10	3.2	68	7.8	2.3	79	1.2	8.3
11	1.0	Jul 8	148	2.5	85	80	5	33	20	5.4	69	7.7	2.2	4.0	1.0	4.7
12	0.2	Jul 8	193	8.1	135	130	5	-	55	13	74	7.6	5.2	-	1.5	12.0
13	0.2	Jul 9	335	15.5	430	275	155	100	170	65	131	7.6	83	39	2.8	44.0
14	0.2	Jul 9	114	1.3	100	90	10	375	20	2.8	65	7.7	6.0	3.1	1.0	5.1
15	0.2	Jul 9	420	10.0	590	510	80	143	220	100	209	8.4	20	40	2.5	37.0
16	0.2	Jul 9	140	1.6	90	86	4	30	40	6.0	66	7.7	2.7	5.6	1.1	7.5
17	0.2	Jul 9	155	2.5	115	105	10	78	40	7.5	72	7.8	8.5	9.4	1.3	12.0
18	0.2	Jul 9	123	1.0	75	72	3	6	20	1.6	62	7.8	1.8	2.2	0.9	3.7
19	0.2	Jul 9	170	10.0	140	125	15	1125	40	11	74	7.8	23	24	1.9	25.5
20	1.0	Jul 9	225	7.4	180	150	30	250	95	30	98	7.7	37	16	1.6	18.5
21	0.2	Jul 9	136	2.5	90	85	5	30	40	4.2	66	7.8	5.7	6.2	1.2	7.8
22	1.0	Jul 9	185	4.8	140	125	15	58	55	13	79	7.8	17	133	1.5	14.5
23	0.2	Jul 9	590	75	675	565	110	500	365	150	159	7.8	55	110	5.0	140

. . . continued

TABLE 2: Continued

Sample No.	Depth m	Date	Conduc-tivity umhos/cm	Chlorides as Chlorine	Solids Total	Diss. Susp.	Phenol ppb	COD	BOD	Alkal-inity	pH	Turbid-ity F.T.U.	Sodium as Na	Potas-sium as K	Sulphate as SO ₄	
24	1.0	Jul 10	142	2.3	90	80	10	45	40	4.0	66	7.6	6.5	6.0	1.1	6.8
25	0.2	Jul 10	142	2.4	90	80	10	37	40	5.5	65	7.8	6.7	6.0	1.1	7.3
26	1.0	Jul 10	190	4.4	150	135	15	81	65	24	26	7.7	13	16	1.5	18.0
27	0.2	Jul 10	150	2.7	100	95	5	58	40	7.0	68	7.8	6.5	7.4	1.1	8.5
28	1.0	Jul 10	150	3.4	110	100	10	65	40	7.0	68	7.8	7.0	7.4	1.1	8.2
29	1.0	Jul 10	154	4.0	125	115	10	42	40	8.5	68	7.8	6.4	13.0	1.3	13.0
30	1.0	Jul 10	317	4.9	340	320	20	88	150	65	109	7.8	18	15.0	1.5	17.0
31	0.2	Jul 10	138	1.9	80	75	5	63	20	6.0	64	7.9	5.4	5.8	1.1	8.7
32	1.0	Jul 10	146	2.6	100	90	10	56	20	7.5	68	7.8	7.6	5.4	1.1	6.4
33	0.2	Jul 10	390	6.6	455	410	45	138	205	50	118	7.8	27	34	2.5	44.0
34	0.2	Jul 10	227	6.7	200	180	20	94	95	26	93	7.8	14	22	1.8	25.0
35	1.0	Jul 10	148	3.4	115	105	10	35	20	5.0	69	7.8	6.7	7.1	1.2	8.0
36	1.0	Jul 10	137	2.4	105	100	5	20	20	2.6	66	8.0	7.3	4.7	1.1	6.2
37	0.2	Jul 10	136	2.7	115	110	5	19	40	3.4	65	7.9	6.3	5.3	1.1	5.8
38	1.0	Jul 10	146	3.2	120	110	10	33	40	5.5	64	7.9	0.95	6.6	1.1	7.4
39	0.2	Jul 10	217	5.9	215	200	15	81	40	23	66	7.8	0.70	19	1.7	23.0
40	1.0	Jul 10	140	3.0	100	95	5	25	35	3.4	92	7.9	5.0	6.2	1.1	6.8
41	0.2	Jul 10	158	3.7	120	110	10	85	20	8.5	67	7.9	7.3	9	1.3	9.7
42	0.2	Jul 10	207	5.6	180	170	10	100	75	27	71	7.8	13	18	1.7	20.5
43	0.2	Jul 10	225	6.9	220	210	10	106	75	28	82	7.8	13	28	1.9	26.0
44	1.0	Jul 15	138	1.7	120	110	10	45	35	3.4	76	7.8	-	4.4	1.0	7.5
45	1.0	Jul 15	160	2.2	145	135	10	70	35	3.8	73	7.7	-	9.7	1.2	16.0
46	0.2	Jul 15	176	2.5	155	145	10	73	75	11	73	7.7	-	11.0	1.3	18.0
47	1.0	Jul 15	167	2.2	140	130	10	66	35	7.5	71	7.7	-	9.9	1.2	15.0
48	0.2	Jul 15	250	2.9	260	235	25	263	145	42	87	7.8	-	25	1.8	38.0
49	1.0	Jul 15	127	1.3	80	75	5	10	20	1.2	62	7.9	-	2.5	0.8	4.3
50	0.2	Jul 15	128	1.3	110	90	20	7	20	0.8	63	7.9	-	2.2	0.8	3.6
51	1.0	Jul 15	126	1.2	95	91	4	3	10	1.4	62	8.0	-	1.9	0.7	3.3
52	0.2	Jul 15	344	4.3	370	345	25	488	215	70	102	7.7	-	44	2.6	22.5
53	0.2	Jul 15	193	2.8	195	185	10	150	75	23	77	7.8	-	25	1.8	40.0

All results in mg/l unless stated otherwise

L means less than

TABLE 3: Chemical Analysis for Fatty and Resin Acids, Red Rock 1974 Samples

Sample Number	Myristic Acid	Palmitic Acid	Stearic Acid	Pimaric Acid	Levo Pimaric Acid	Sandaraco Pimaric Acid	Iso Pimaric Acid	Abietic Acid	Dehydro Abietic Acid
13 ^a	0.11	0.10	0.05	0.03	N.D.	0.01	0.08	0.27	0.12
16 ^a	0.04	0.02	0.01	0.01	N.D.	Tr	0.03	0.06	0.04
18 ^a	0.03	0.03	0.01	0.01	N.D.	Tr	0.02	0.05	0.01
19 ^a	0.08	0.08	0.04	0.05	N.D.	0.01	0.04	0.21	0.05
20 ^a	0.19	0.08	0.04	N.D.	N.D.	N.D.	0.06	0.26	0.09
21 ^a	0.04	0.03	0.02	0.01	N.D.	0.01	0.03	0.09	0.01
22 ^a	0.04	0.03	0.01	0.01	N.D.	Tr	0.03	0.09	0.06
b	0.67	0.18	0.10	0.64	N.D.	N.D.	1.07	3.50	6.94

Note:

All values in ppm

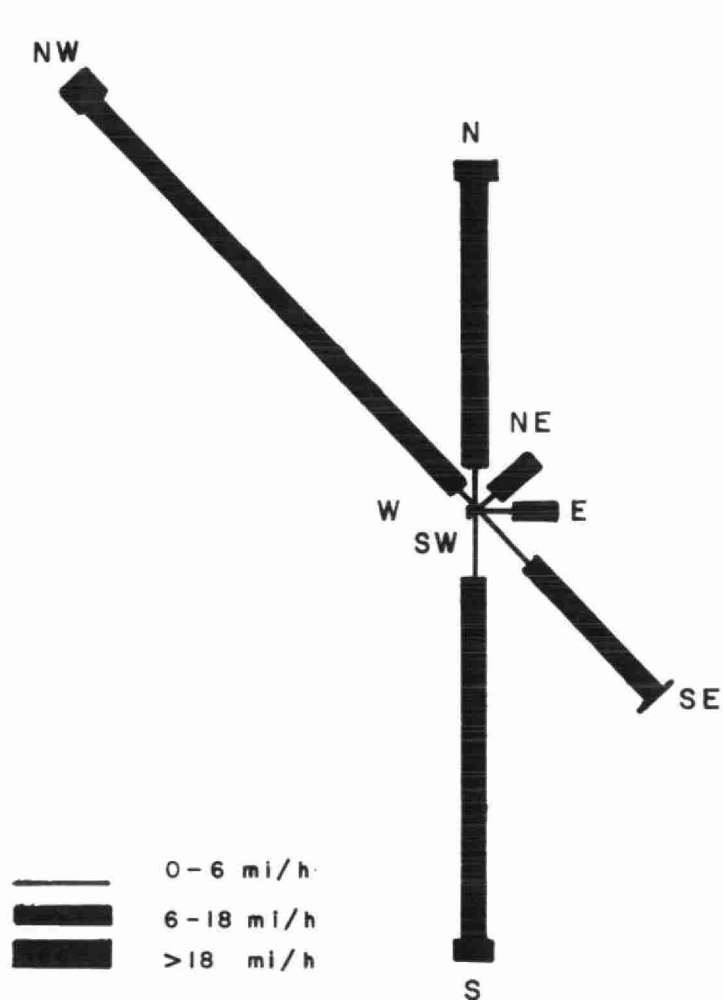
Tr means trace

N.D. means none detected

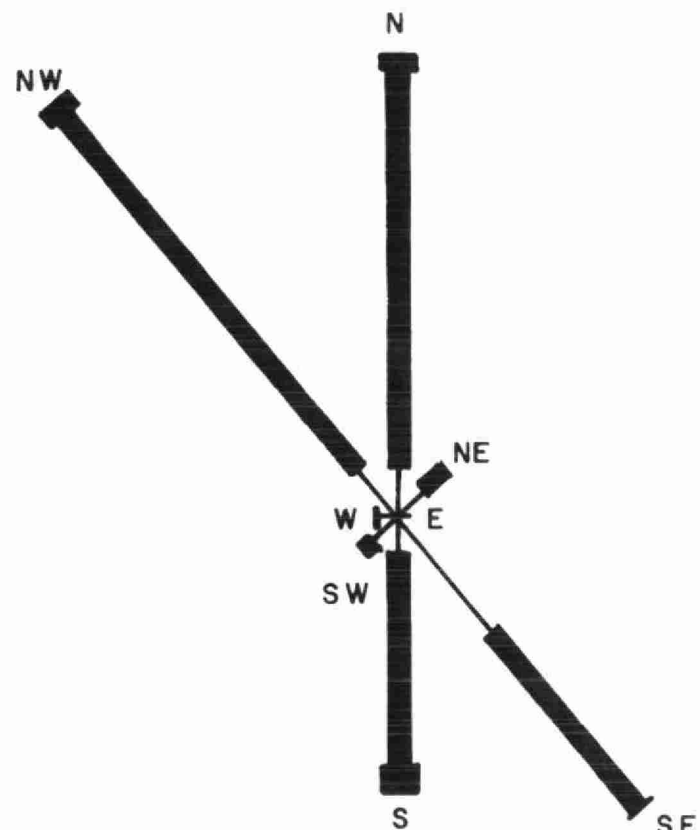
a - sample numbers identical with those given in Table 2

b - sample taken in the outfall ditch at the third foam barrier on July 9

WIND DIRECTIONS AS GOING TO



JULY - AUGUST 1974



JUNE - JULY 1975

FIGURE 1 : WIND ROSES, RED ROCK

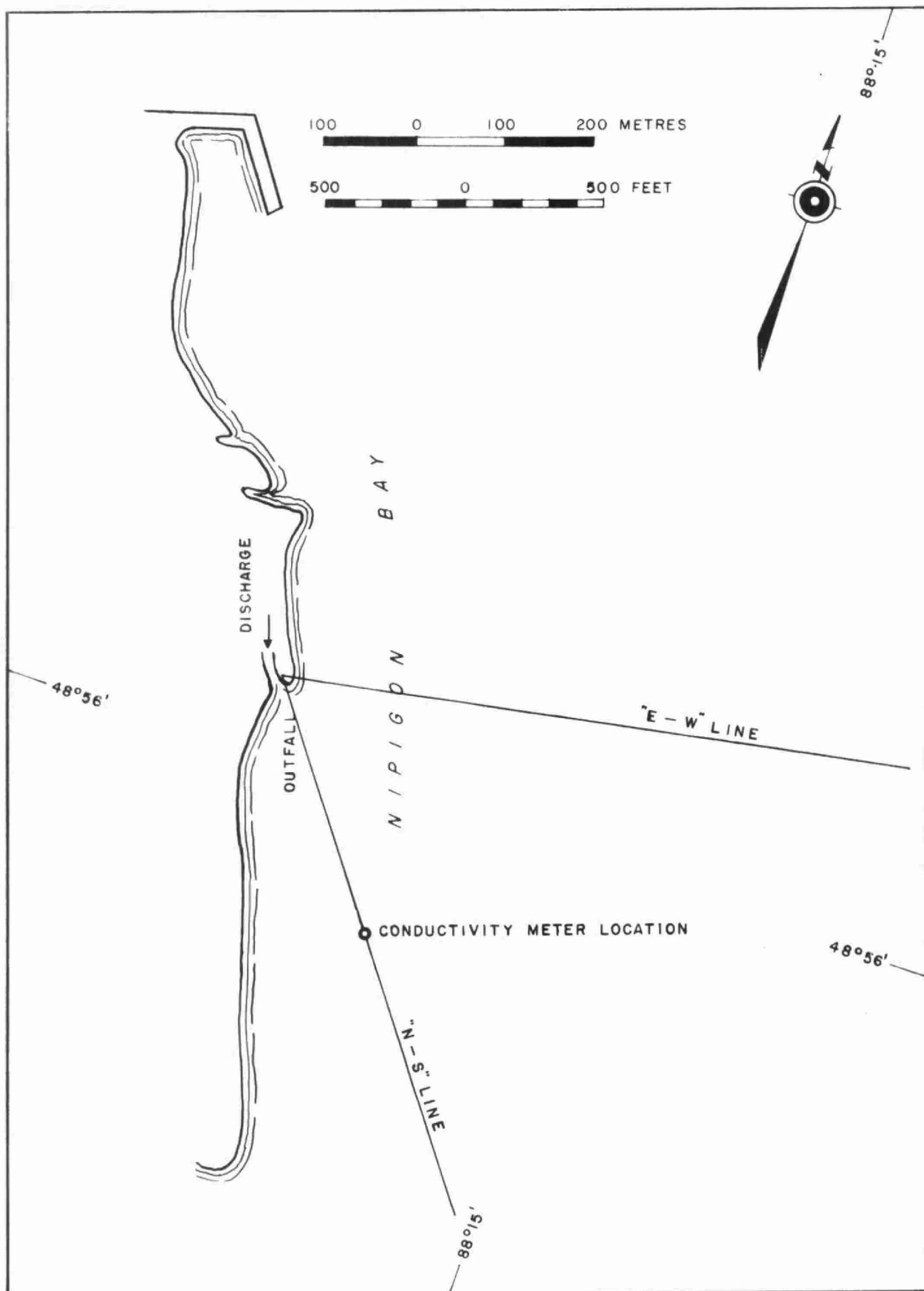


FIGURE 2 : LOCATION OF THE CONDUCTIVITY METERS IN 1975 SURVEY

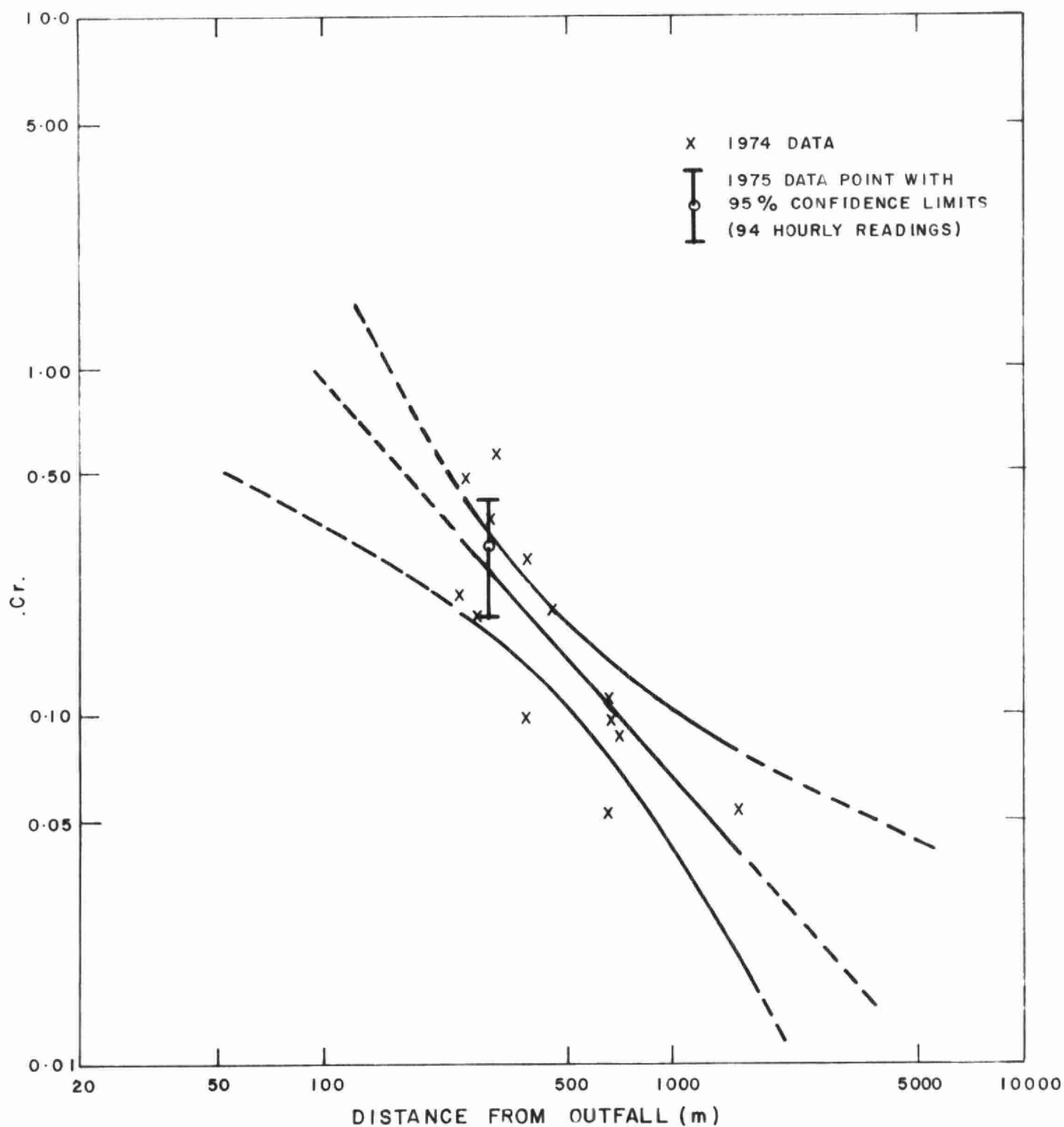


FIGURE 3 : DEPENDENCE OF C_r ON THE DISTANCE FROM THE OUTFALL
 N W WINDS

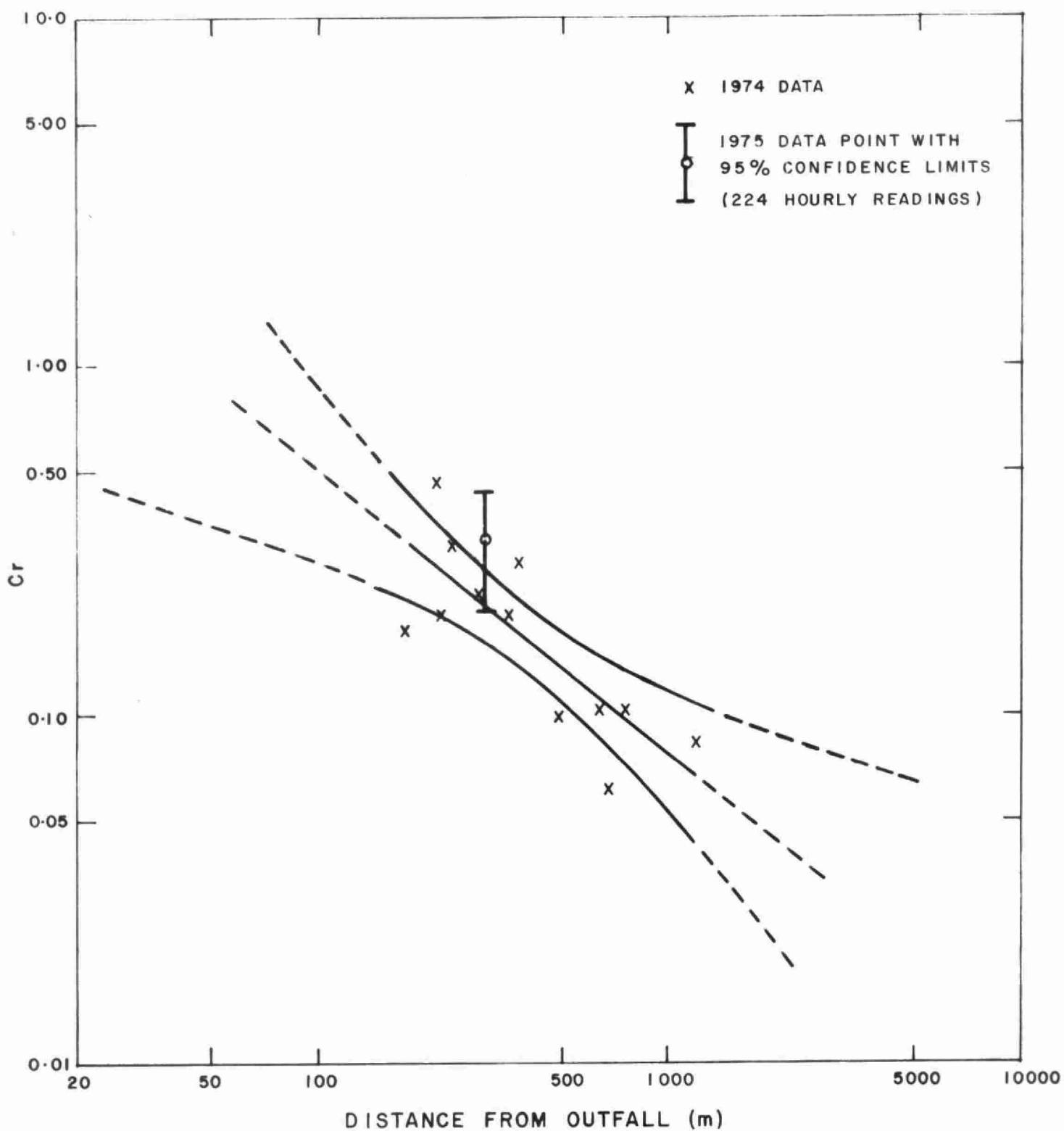


FIGURE 4 : DEPENDENCE OF C_r ON THE DISTANCE FROM THE OUTFALL
SE WINDS

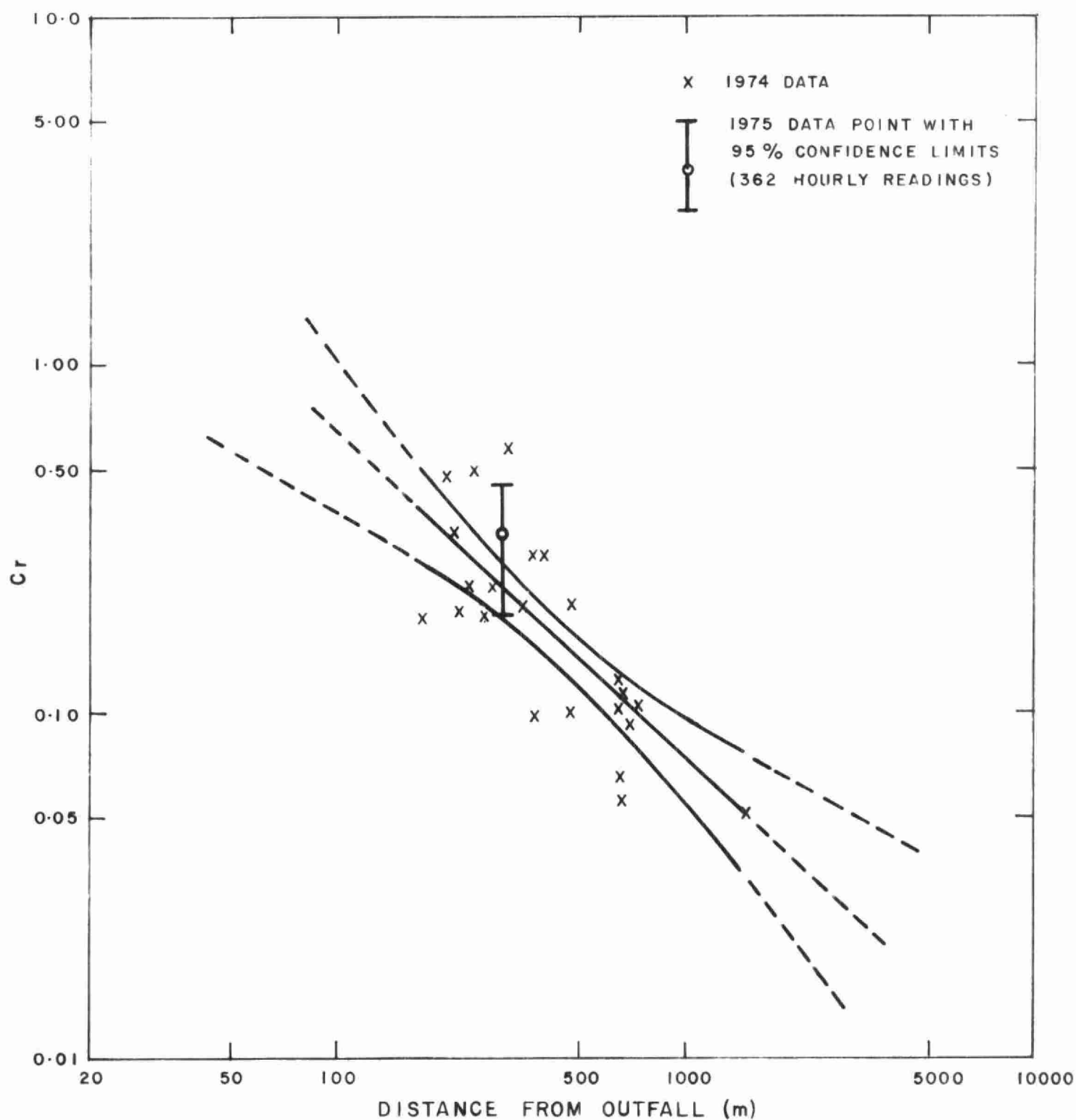


FIGURE 5 : DEPENDENCE OF C_r ON THE DISTANCE FROM THE OUTFALL
ALL WINDS

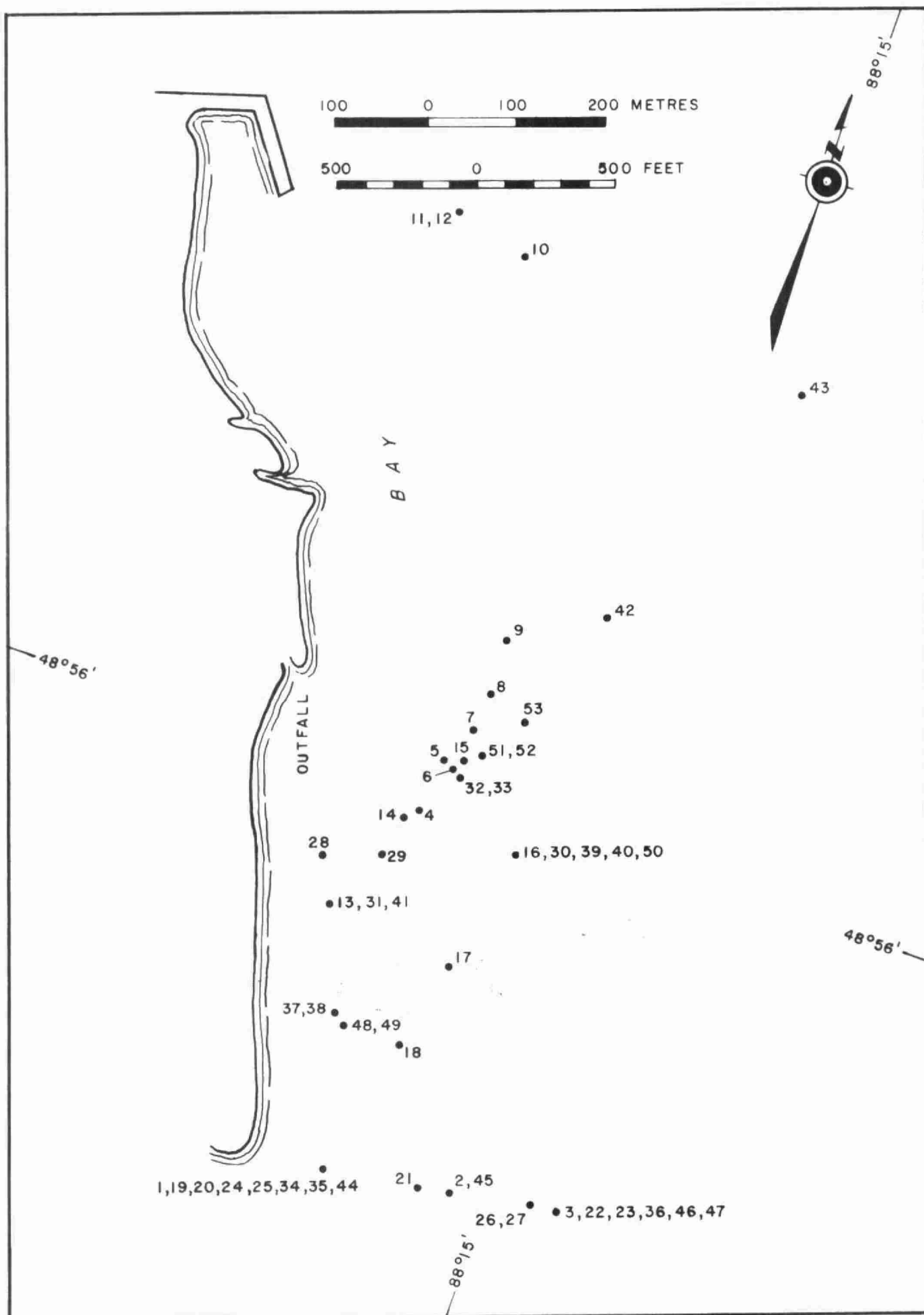


FIGURE 6 : CHEMICAL SAMPLING LOCATIONS RED ROCK 1974



(8103)

MOE/RED/ALNB

MOE/RED/ALNB

Polak, J

Red Rock DOMTAR

effluent plume

alnb

c.1

a aa